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File 2807
J. Spiegel
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January 25, 1963

N64 33776 (ACCESSION NUMBER) (THRU)
7 (PAGES) 1 (CODE)
CR-56390 (NASA CR OR TMX OR AD NUMBER) 10 (CATEGORY)
FACILITY FORM 602

[redacted]

Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, California

Attention: Mr. Walter A. Frohn, Contract Negotiator

Subject: December Monthly Letter Report, Contract 950297, Submittal of

Dear Mr. Frohn:

Enclosed please find seven (7) copies of subject report (one (1) copy reproducible and six (6) print copies) as required by Contract 950297.

Very truly yours,

*E. A. Blum*

E. A. Blum
Contract Administration

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P.S. Figures 3, 4 and 5, of which only one set is included, are for Mr. J. M. Spiegel.

ON VALUE

[redacted]

SUBJECT: Monthly Progress Report -- Hypervelocity Studies in Simulated Planetary Atmospheres -- Contract No. 950297

PERIOD: December 25, 1962 - January 25, 1963

The following describes the activities on the subject contract during the past month.

## ANALYTICAL

The computations of shock tube performance for the 3% $CO_2$ mixture for 4 initial driven tube pressures have been completed. Also, the same parameters have been extended for the 9% and 25% $CO_2$ mixtures. The plot of these quantities for shock velocities up to 36,000 ft/sec is in progress and will be forwarded to Mr. J. M. Spiegel as soon as completed.

The response of the cavity gage to a parallel beam of light was computed. For this approach a specular reflection of the incident energy was assumed. The results, which are plotted in Fig. 1, represent energy loss due to final reflectivity of the platinum film inside the cavity. The loss, which is defined as the ratio of the energy escaping the cavity through the entrance slit after a large number of reflections, is shown as a function of the film reflectivity. The reflectivity of the film depends on the wavelength of the incident radiation as is shown in Fig. 2. It is notable that the total loss will be less than 5% when the reflectivity remains below 0.70. Since the bulk of radiation which the cavity gage is to measure, both from the stagnation region and from behind the incident shock lies below wavelength $\lambda < 0.80$ microns the corresponding reflectivity of the surface will be below 0.70 and hence the integrated loss should be even less.

[redacted]

## EXPERIMENTAL

Since December 6, 1962, when the new 6.0 in. dia. hypervelocity shock tube became operational, a total of 30 test runs have been performed. The initial difficulties with the triggering sequence of the signal recording oscilloscopes have been overcome. Also, the driver continues to perform according to predictions. Several runs were performed using the 9% $CO_2$ mixture as the test gas. Stagnation point heat transfer on hemispherical model with nose radius 0.50 in. was measured. One of the important results is the confirmation of the available test time. In Fig. 3 the trace of the output signal from the photomultiplier focused on the stagnation region in the shock layer ahead of the model is shown. The initial conditions are stated in the figure. The duration of the quasi-steady flow is sharply defined by the steep rise of the emitted radiation and sudden decrease at the termination of the steady flow. The small variation of intensity during that period corresponds to much smaller variation of gas temperature since the intensity is proportional to about $T^9$. The test time in this case can be taken to be about 25 $\mu$sec. In Fig. 4, a similar signal for shock velocity of $U_s$ = 28,600 ft/sec and initial driven tube pressure $P_1$ = 0.55 mm is shown. The corresponding steady flow duration is about 18 $\mu$sec.

The model used for measuring the heat transfer rate to the stagnation point was 1.0 in. diameter. A platinum gage 0.002 in. thick was used as the sensing element. Initial runs produced signal from the gage which had two undesirable characteristics. A strong negative going potential (precursor) was observed prior to the arrival of the incident shock wave at the model.

Also a fair amount of noise was superimposed on the thermal signal once the flow around the model was established. A solution to this problem was found to lie in the grounding of the gage. The resulting great improvement in the signal quality can be assessed from Fig. 5.

The measured heat transfer rates are generally lower than the theory of Scala would predict. Also they lie below our earlier published data obtained in the 2.0 in. dia. hypervelocity shock tube. Most of these early data were obtained using 0.004 in. thick Hytemco gages. Recent data, on the other hand, were from 0.002 in. platinum gages. In trying to resolve the differences between these data we concluded that the gage material and the thickness of the sensing element may be contributing factors. Therefore we cannot conclude that the lower values given by the platinum gages are correct until we investigate these points in our new tube. In the best interest of the present program the discrepancies should be determined, through a short experimental program, prior to proceeding with the scheduled convective heat transfer studies.

## FUTURE WORK

The plotting of the shock tube performance for all three gas mixtures will be concluded. Also completed will be total radiation calculations for conditions behind incident shock and the stagnation point. Use of the latest Breene theoretical predictions will be used.

Resolve the effect of gage material and thickness on the measured heat transfer rates. This will be done under internal funding.

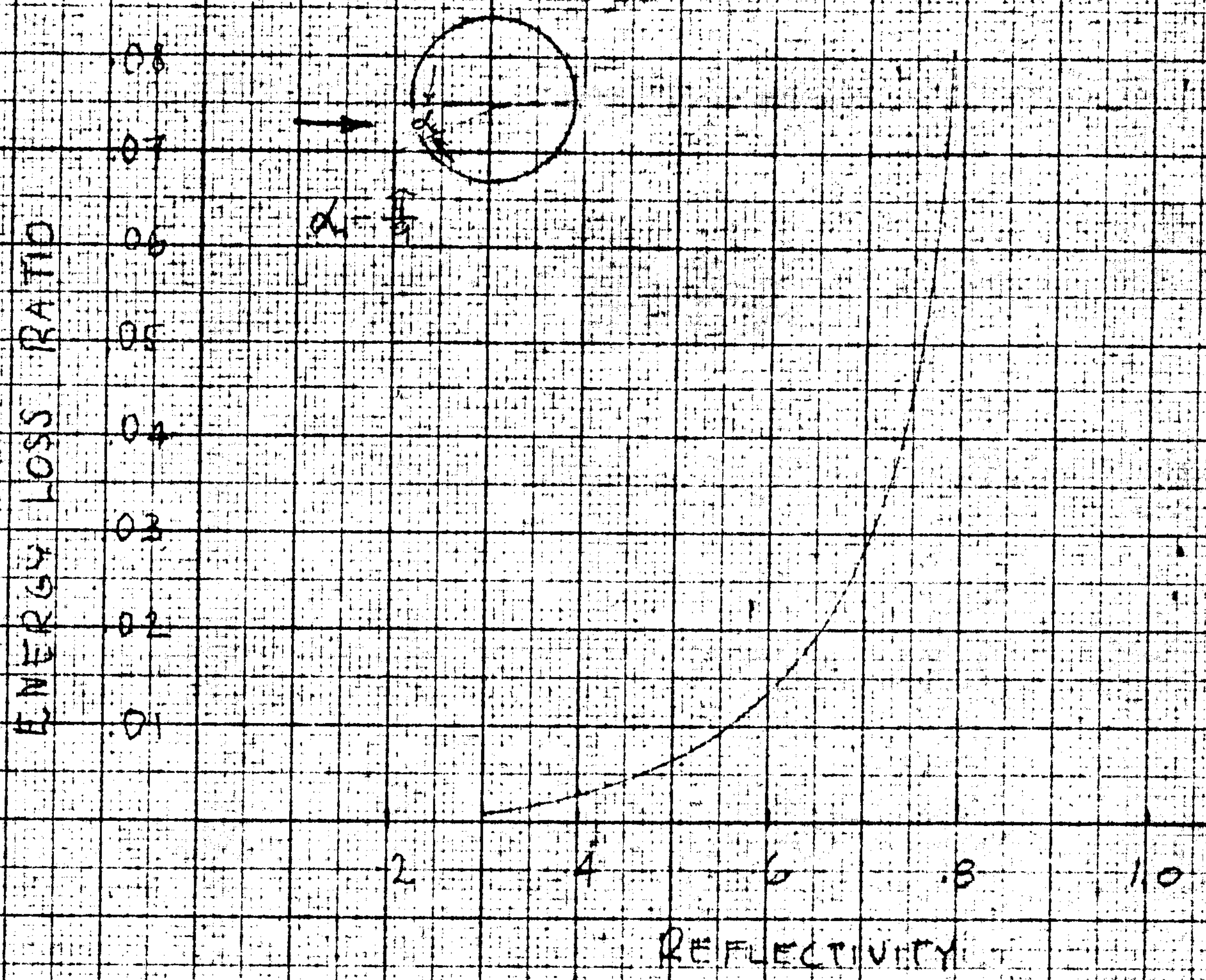
Conclude convective heat transfer tests as specified in the contract.

Take time resolved spectrograms of the gas behind the incident shock and from the stagnation point.

Prepare to measure stagnation point radiant heat transfer using a cavity gage mounted in the 3.0 in. model.

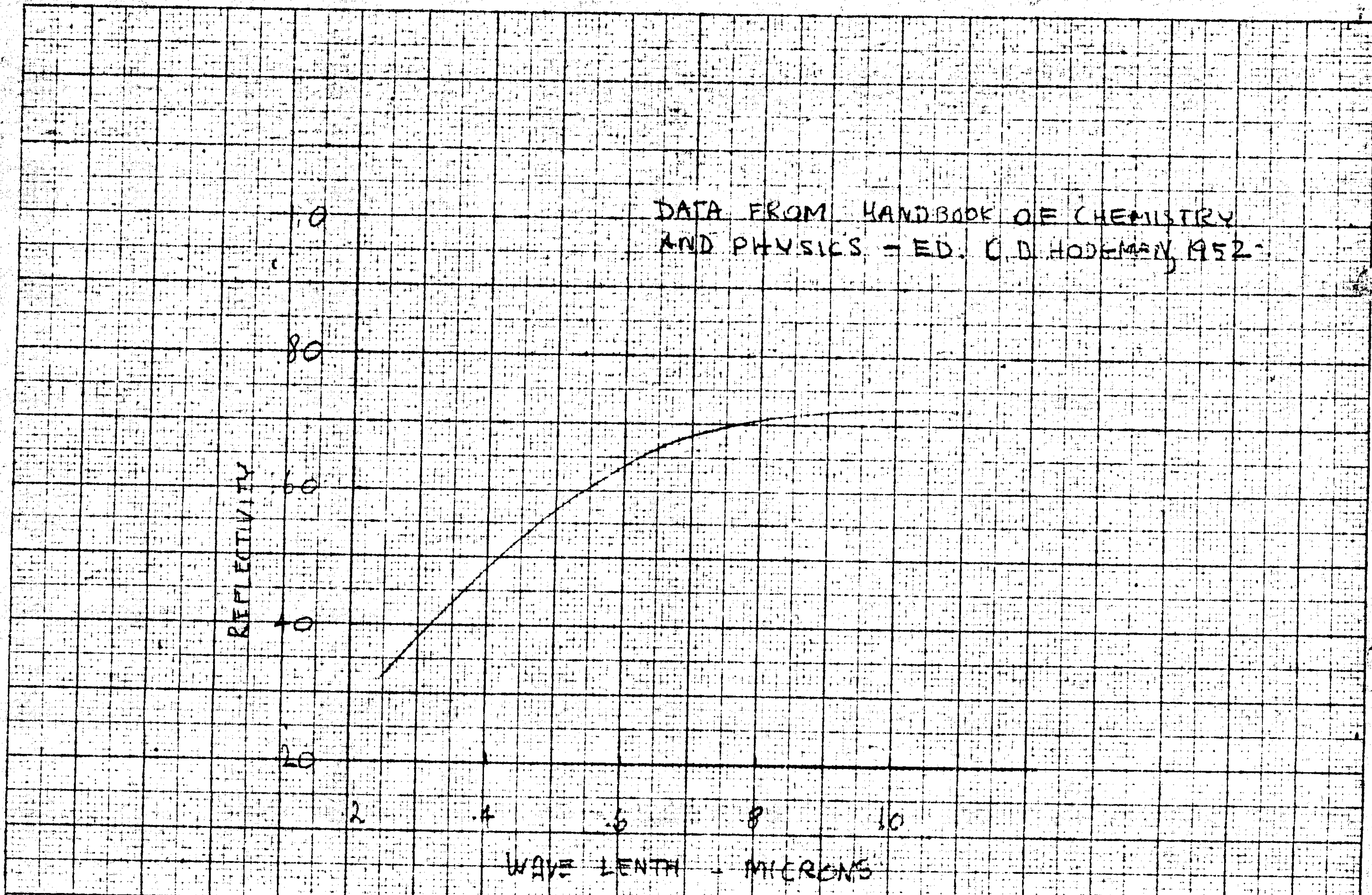
J. S. Gruszczynski
Specialist, Hypersonic Aerodynamics
Aerothermodynamics Research

jsh




ENERGY LOSS RATIO AS FUNCTION OF PLATINUM FILM REFLECTIVITY FOR FIXED GEOMETRY OF COLLECTOR

FIG. 1




REFLECTIVITY OF PLATINUM THIN FILM ELECTRODEPOSITED.

FIG. 2